

SESSION 3

Inspection and Maintenance of Dams and Spillways



Objectives for Session

- Importance of inspections
- Examples of inspections and items noted and why it is important to repair these items
- Ways to address
- Examples of good maintenance



Why are inspections and
maintenance important?



“Maintenance is needed to continue to realize local benefits and to keep the dams safe.”

▶ National Watershed Coalition, 2010



Inspection is the key element of a good owner's dam safety program



Regardless of the type of dam,
all dams must be properly
operated, maintained, and
inspected by owners



Good inspection and maintenance program

- ▶ Will identify deficiencies early
- ▶ Will protect against deterioration and will prolong life
- ▶ Will protect the owner and as well as the public
- ▶ Will have a small cost compared to costs of major repairs, loss of life and property, and litigation



Inspection frequency for owners

- ▶ High and significant hazard dams
 - Quarterly
 - Annually by an engineer, not necessarily a consultant. Could be a staff person
 - After flood events or earthquakes
- ▶ TCEQ inspects every 5 years, if possible. More often if condition has been determined to be poor during previous inspection







Inspection of a dam





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Crest of the dam













What did we find on the crest?

- ▶ Sparse grass cover with bare areas
- ▶ Grass cover needing mowing
- ▶ An ant mound
- ▶ Hole in the crest



What did we recommend?

- ▶ Re-establish a grass cover, if at all possible. Drought is preventing, or hurting, development or maintaining a grass cover
- ▶ The grass needs to be mowed on a regular scheduled basis (three times a year preferred)



What did we recommend?

- ▶ The hole noted in the crest should be filled.
- ▶ The ant mounds should be poisoned to prevent the ants from causing problems with the dam. Pay special attention for ants around the electrical panel on the crest of the dam.



Upstream slope of the dam







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What did we find on the upstream slope?

- ▶ Small trees in riprap
- ▶ Holes in riprap coverage
- ▶ Wave action erosion along water line



What did we recommend?

- ▶ The trees on the slopes of the dam should be removed. Some of the trees had been poisoned, while others had not. A periodic removal or spraying schedule should be established and followed.
- ▶ As the lake level rises, the rock riprap should be monitored for movement. The monitoring may need to be done by boat. If wave action results in movement of the rock, a process should be established for replacement of the rock.



What did we recommend?

- We made no recommendation on the wave action erosion since the lake was continuing to rise. Normally, we recommend:
 - Reestablishing slope protection including bedding material. An engineer may be required to design the slope material.
 - Flattening the slope before replacement of the slope protection.



Downstream slope of the dam







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What did we find on the downstream slope?

- ▶ Lack of good grass cover
- ▶ Tall Johnson Grass on portions of the slope
- ▶ Hog damage
- ▶ Erosion at left groin
- ▶ Trees and vegetation around toe drain outlets
- ▶ Damaged toe drain outlet wall
- ▶ Piezometers (Readings taken?)



What did we recommend?

- ▶ The trees and other vegetation around the toe drain outlets should be removed. A periodic removal or spraying schedule should be established and followed.
- ▶ The pipes also need to be maintained clear. Periodic inspection of the outlets is recommended for any seepage flow.
- ▶ The downstream slope needed to be mowed and the grass cover needed to be reestablished.
- ▶ The hog damage on the slope should be monitored and repairs made as necessary.



What did we recommend?

- ▶ The erosion along the left groin of the dam should be monitored and repaired as necessary. Use of small dikes to divert the water flow from the hillside may be necessary.
- ▶ The toe drain outlet head wall that had been damaged needs to be repaired to prevent deterioration of the concrete due to exposure of the reinforcing steel. A method for marking the locations of the outlets was recommended to prevent mowers for hitting the walls.



What did we recommend?

- ▶ It was recommended that the piezometers along the downstream toe be investigated to determine if they are functional. If they are still functional, they should be periodically read and the readings evaluated (history of water loss from the reservoir).



Spillways















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What did we find in the spillways?

- ▶ Vegetation in the joints, cracks, and pressure relief holes
- ▶ Cattails in the spillway stilling basin
- ▶ Rocks falling on the concrete
- ▶ Cracks in the concrete
- ▶ Voids in the emergency spillway protection
- ▶ Trees in the channel and on the side slopes
- ▶ Erosion in the channel and on the side slopes



What did we recommend?

- ▶ The trees in the spillway should be removed. A periodic removal schedule should be established and followed.
- ▶ The vegetation in the joints and pressure relief vent holes in the spillways should be cleared, and the joints and holes should be maintained clear of vegetation. The joints should then be sealed.
- ▶ The cracks in spillways should be monitored and sealed as necessary.



What did we recommend?

- ▶ The cattails in the service spillway stilling basin need to be removed.
- ▶ The rock that has fallen on the service spillway and the side slopes should be removed periodically. Flow through the spillway can cause damage to the spillway due to the rocks. The concrete should be inspected during the removal process to detect any damage to the concrete from the rocks falling on the concrete.



What did we recommend?

- ▶ The erosion in the spillway discharge channel has increased in size due to rainfall runoff. Some of the gullies have become quite deep. The erosion should be repaired, and some type of protection placed. An inspection should be made if there is ever a flow through the spillways.





Inspection of another dam



















What did we find on the dam?

- ▶ Trees, trees, and trees
- ▶ Lack of grass cover
- ▶ Blocked service spillway drop inlet
- ▶ Erosion around the outlet



What did we recommend?

- ▶ The smaller trees, 4-inches or less, and other vegetation on the dam should be removed. The stumps should be treated with a waterproof sealant to prolong stump decay. A professional engineer should be contacted if the roots are to be removed.
- ▶ A periodic removal or spraying schedule should be established and followed. Tree roots can become pathways for seepage and can alter the structural integrity.
- ▶ Trees can blow over in high winds and severely damage the embankment.



What did we recommend?

- ▶ After tree removal, establish a good grass cover.
- ▶ Remove all vegetation and debris from around the service spillway drop inlet to allow water to flow through the inlet.
- ▶ The erosion around the service spillway outlet needs to be repaired and protected.

















What did we recommend?

- ▶ One of the most common maintenance problems at embankment structures is erosion.
- ▶ Periodic and timely maintenance is essential to prevent continuous deterioration and possible failure.
- ▶ The cause of the erosion will have a direct bearing on the type of repairs.



What did we recommend?

- Erosion gullies
 - Restore the slope by repairing the area with competent material and compacting material.
 - Address the cause for the erosion.
 - Cover the repaired area with topsoil, if possible.
 - Re-vegetate the repaired area, if possible.







Other inspection items

- ▶ Cracking
- ▶ Seepage
- ▶ Animals
- ▶ Rutting
- ▶ Pipes







What do we recommend?

- ▶ Structural cracking is usually associated with movement of the dam and needs the attention of an engineer to determine the cause of the cracking and to make recommendations for correction.
- ▶ Desiccation cracks are usually associated with drying due to lack of rain and can result in saturation of the dam when rains occur, which could result in slides. Cover cracks with top soil and re-vegetate the area.







What do we recommend?

- ▶ Continued flows, especially carrying soil material, can saturate parts of the dam and lead to slides, erosion, or failure due to piping through the dam.
- Monitor seepage regularly to determine if flow is increasing or if soil material is being carried in the flow. Document with photos or flow characteristics.



What do we recommend?

- If quantity of flow starts increasing or the flow becomes muddy, an engineer should be retained to evaluate the condition and make recommendations for further action.
- May require lowering the lake level.



What do we recommend?

- If a boil develops along the downstream toe, an engineer needs to be retained as soon as possible to determine what action needs to be taken.
- May require lowering the lake level.





01/29/2013



What do we recommend?

- ▶ Ruts and low areas can collect rain water, which can cause saturation and softening of the dam. Low areas could be sign of settlement or collapse of animal holes.
- For ruts, drain any standing water, re-grade and re-compact fill, slope crest to upstream slope, and periodically re-grade.



What do we recommend?

- For low areas on large and intermediate size dams:
 - Install monuments to determine if settlement is occurring. Take readings on time frame recommended by engineer and have engineer evaluate readings.



What do we recommend?

- For low areas on small dams:
 - Determine if low areas are the result of collapse of animal dens. If so, carefully excavate holes and replace and compact soil.
 - Fill in other low areas and re-compact.
 - Re-vegetate areas.





Animals, why be concerned?

- ▶ Burrowing animals can endanger the structural stability of the dam by weakening the embankment and serving as pathways for seepage.
- ▶ Burrowing animals, like beavers, are creating more problems
- ▶ Hogs destroy the protective vegetative cover
- ▶ Livestock trails can promote severe erosion
- ▶ Livestock can overgraze the vegetative cover



What do we recommend?

- ▶ Take measures to eliminate the animals.
- ▶ For burrows/dens, excavate, backfill, compact, and seed. Also, you can fill hole with grout, cover with soil, and seed or re-vegetate.
- ▶ For livestock trails, fill with soil and compact and then re-vegetate.





What do we recommend?

- ▶ Pipe deterioration is usually associated with a corrugated metal pipe (CMP).
- ▶ Deterioration usually requires replacement of the pipe or slip-lining the pipe with a smaller pipe and grouting between the pipes.
- ▶ If the pipe is replaced, do not replace with another CMP. CMPs should not be used in dams.
- ▶ This will require an engineer and should be undertaken as soon as possible to avoid erosion of the dam.





What do we recommend?

- ▶ Clear vegetation around drain and well outlets
- ▶ Measure and monitor flow from outlets
- ▶ Keep outlet clear of algae, especially those with flap gates
- ▶ Have engineer evaluate data from drains and wells



Inspection of a large dam













10/29/2012









12/03/2008





What do we recommend?

- ▶ For wave action erosion, reestablish the slope protection including bedding material, possibly after flattening the slope. An engineer may be required to design the slope material.
- ▶ Spalling and large joint openings generally require an engineer's evaluation to determine cause, if movement is occurring, and method of repair. For small cracks and narrow open joints, the cracks and joints should be cleaned and sealed with a flexible, water resistant sealant.



What do we recommend?

- ▶ Monitor any flow from any drainage system. Keep the drainage openings clean.
- ▶ Maintain the gate arms clean of debris. Maintain any drainage openings in the arms clear.
- ▶ Lubricate the trunnions.
- ▶ Address corrosion and gate seals as necessary.
- ▶ Make sure the gates work.









MAR 13 2014





- *Guidelines for Operation and Maintenance of Dams in Texas*
- *Dam Removal Guidelines*



Web Site

- ▶ The web site for the rules and the guidelines is:
- ▶ http://www.tceq.texas.gov/compliance/field_ops/dam_safety/damsafetyprog.html



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Questions

